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I, JANENE PEISKER, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. 2004905617 for a patent by PHILLIP JAMES as filed on 30 September 2004.

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TEAM LEADER EXAMINATION
SUPPORT AND SALES

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AUSTRALIA

[Patents Act 1990]

Provisional specification

Standard patent

LEANING VEHICLE

The invention is described in the following statement:

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AUSTRALIA

[Patents Act 1990]

Provisional specification

LEANING VEHICLE

The invention is described in the following statement:

8 pages text.
13 pages diagrams

LEANING VEHICLE

This invention relates to the field of narrow leaning vehicles which have overall dimensions similar to a normal motorcycle, and which obtain their stability by inclination of the vehicle/occupant mass to offset the effects of centrifugal force when cornering. This invention sets out a simple system of control to replace the complex control used on a conventional motorcycle. This will enable the widespread use of narrow leaning vehicles by operators of average skill. The advantage of such a vehicle is the reduction of the energy required to transport the occupants and the reduction of the space required to park the vehicle, combined with an incentive for the use of the vehicle due to its simple control and inherently satisfying dynamics. In order to achieve this ability the leaning vehicle described in this invention uses what is termed "simple steer". The steer of the vehicle is directly related to the movement of the control. A torque or displacement of the control to the left produces a turn to the left by the vehicle, as is the case in a conventional motor car and unlike that of a conventional motorcycle which uses a complex steer or fractured driver input system due to the need for the driver to balance the vehicle as well as to steer it.

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The vehicle of my invention uses leaning and castoring wheel/wheels to create the steered vehicle path .The conventional wisdom dictates that a narrow leaning vehicle cannot be "force leaned" without creating an overturning moment upon the vehicle as the force is applied. This is caused by the rest inertia of the vehicle mass resisting the applied force. All force leaned vehicles in the prior art suffer from poor lean speed performance due to this problem. The solution has been to use a wide track and apply large force to lean the vehicle which is fundamentally counter productive. Many experimenters have realised the value of countersteer as a means to accelerate the leaning mass and have devised various means to use countersteer of the vehicle wheels but retain a simple steer driver input. These vehicles have become known as "automatic countersteer" vehicles. The vehicle of my invention is an automatic countersteer vehicle but the means by which it achieves this function is not obvious.

With reference to FIG [1] I will briefly describe how a vehicle with freely castoring wheels will automatically countersteer its wheels upon the application of a force to lean the vehicle. With reference to FIG[1] an illustrative example is given. A force applied between the pivoting mass and the plank as depicted by the double pointed arrow, causes the plank to react and move as depicted by the single pointed arrow, and roll upon the rollers. Transforming this understanding to the FIG[1a] it will be seen that the reaction within a leaning vehicle parallelogram, which supports the wheels and allows the lean of the vehicle, will be identical, and if the wheels have a trail caused by the contact patch being behind the steer axis [in the example into the page], relative to the reaction force on the parallelogram lower cross arm, then the two wheels are caused to countersteer in the opposite direction to the direction of the force applied to lean the vehicle mass. The amount of countersteer imparted depends on the observed magnitude of the rest inertia of the leaning mass. It is this reaction which gives the vehicle of this invention exceptional lean speed performance. If the "forced to lean" parallelogram is placed at the rear of the vehicle with front wheel/wheels castoring the result is similar. A full understanding of the details of the nature of these effects is not attempted in this document and is in fact not needed as no claims are made with regard to this effect. The fundamental information is included purely to assist the reader to better grasp the operation of the vehicle.

Multi wheeled leaning vehicles can take various forms. Please refer to FIG [2]. Vehicle [a] has two front wheels leaning two rear wheels not leaning. Vehicle [b] has two front wheels and one rear wheel all leaning. Vehicle [c] has four wheels ,all leaning. Vehicle [d] one front wheel leaning two rear wheels not leaning and Vehicle [e] has one front wheel and two rear wheels all leaning. The principle outlined in my invention can be applied to all vehicle types.

The prior art which is most associated with my invention is contained in WO9534459. This describes a leaning vehicle where the driver input control position is compared to the position of a castoring wheel mounted on the leaning structure, by a sensor which directs power to tilt the vehicle. As the vehicle tilts due to driver input on the control as observed by the sensor, the castoring wheel steers into a position until the wheel position matches the driver input position, as observed by the sensor. The vehicle then ceases to tilt and is then in a stable curved path. One disadvantage of this arrangement is that any mechanical connection between the driver input and the front wheel [via a torque sensing spring in the sensor] is detrimental to the performance of the vehicle due to a disturbance of the position of the castoring wheel into a positive steer position before the application of the force to lean the vehicle. Likewise, no mechanical connection is possible between driver input and the vehicle lean. Inferior feedback methods are required and there is no mechanical failsafe capacity. The fundamental character of the driver feedback is unlike that of a conventional car because the vehicle produces no feedback in a steady state leaning condition, only upon the application of the driver input to instigate a manoeuvre. My invention places the sensor[servo valve] directly between driver input and vehicle lean and employs direct mechanical feedback and failsafe capacity. The castoring wheel is allowed to countersteer during lean action without this action being suppressed by the use of a torque sensing

spring.The novel methods employed to implement my arrangement are fully described in the body of this patent.

The vehicle of my invention has two fundamental requirements.1],a method for the driver to control the lean angle of the vehicle and 2], a method for the lean angle to produce a steered vehicle path. VEHICLE LEAN: The spacing of at least two wheels laterally allows the application of a force to lean the vehicle or an ability to prevent the vehicle from leaning. The method for the driver to apply the force to control the lean angle is made possible by a laterally spaced wheel set and a connection between the drivers control and the laterally spaced wheel set support structure .This allows the vehicle to have a reference to the road surface and allows the driver to select the lean angle by a simple steer input on the control. VEHICLE STEER: The method to steer the vehicle due to driver induced lean of the vehicle is derived by the use of at least one or optionally two wheels to create a leaning and castoring wheel "element", which leans with the vehicle, the leaning of the vehicle producing an automatic position control of the castoring element, the position being a function of the vehicle lean angle and vehicle speed. In this way the difficult problem of providing a variable lean steer ratio over vehicle operating speed range is overcome. A further important aspect of the arrangement in my vehicle is that it always leans before it steers [although not perceptively to the driver]. If a leaning vehicle steers before it leans it will be subject to a lean force in the wrong direction.

In FIG[3] is shown a leaning vehicle of my invention with a leaning and castoring wheel element,in this case two wheels [not shown], joined in a set and laterally spaced, which are located on a parallelogram linkage. The parallelogram is formed by upper cross arm [8] and lower cross arm [13]. Both arms can pivot on bearings located in the centre of each cross arm which rotate on axles attached to the vehicle structure [17] at points [26,26a]. Ball joints are fitted to the ends of each cross arm, and these joints attach to the uprights [2,2a], forming a parallelogram which can tilt and simultaneously allowing the steering of the uprights. The action of the tilting of the parallelogram and the action of the steering of the uprights are independent , one of the other. Lever arms[1,1a] extend forward from the two wheel uprights[2,2a], and are connected by a track rod [3] which maintains the wheels in the desired alignment. As will be described later, the vehicle is provided with a means to force it to lean due to direct driver input on the control, and because of the parallelogram linkage when the vehicle leans, the wheels also lean. The wheels are arranged to operate with a trail [4] so providing a castoring action. The trail is provided by arranging the geometry so that the tire contact patch in each wheel is rearward of the point where the extension of the king pin axes would strike the road surface. When the vehicle is leaned the front wheels also lean and this causes the front wheels to turn into the direction of the lean. As the vehicle leans the front wheels take up a steer angle which produces and maintains a steered vehicle path which is fundamentally suitable for the lean angle of the vehicle and the speed of the vehicle. The vehicle will be fundamentally balanced at all times, however it is a desirable characteristic of the arrangement that the trail be of a sufficient amount to produce a tendency for the vehicle to return to the vertical position. As previously mentioned the vehicle is arranged to lean by direct influence from the driver using a control, optionally a steering wheel or a steering bar rotatable around a steering column . In FIG[3] is shown a control[5], connecting shaft [6] and gear set [7]. In the gear set one gear is connected to the upper parallelogram cross arm[8] and the other to the extension of shaft [6a] Any other arrangement can be provided which provides a mechanical connection between driver input and vehicle lean. Also shown are two servo valves [10,10a] in series fitted in the shaft [6a].The valve bodies are mounted to the vehicle structure. One servo valve can be used[as described later] or two servo valves can be used as shown to provide additional amplified force to the leaning of the vehicle in the event of a failure of one or the other of the individual power lean systems which operate upon the signal provided by the individual servo valves. A more detailed illustration of the connection of two

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servo valves in series is made with reference to FIG[4].The individual servo valves are arranged so that the output shaft [6]... which could be just as easily the input, is connected through both valves to the input shaft [6a.] Two independent torsion bars[30,30a], are fitted so as to operate as one torsion bar being connected by common support [31].This common support has seals[32,32a] which prevent fluid flow from one valve to the other. Each torsion bar will allow the valves to displace to open under influence supplied as a torque to the input or the output end of the shaft. Mechanical valve stops are fitted in both valves so as to provide a locked mechanical transfer upon the designed full displacement of the torsion bars, ensuring that full mechanical torque can be applied through the system upon the failure of one or all of the components. Each hydraulic section of each valve[10,10a] is connected to separate double acting actuators to power assist the lean of the vehicle, and separate pumps supply each valve section. The fundamental valve design shown is a standard power steer valve well known in the art. Obviously other forms of valves will be used if the chosen system is not hydraulic but instead say, electric or pneumatic. In the FIG [3] a hydraulic system is illustrated. Each servo valve is connected to its own fluid supply pump [11,11a], by connecting delivery lines [not shown] and connecting return delivery lines [not shown], and each servo valve directs fluid to its own double acting actuator. The application of driver applied torque on the control [5] is sensed by the servo valves which direct fluid under pressure by delivery lines [not shown]to the actuators, to cause the actuators to apply a force to lean the vehicle via the parallelogram to power assist the drivers effort. If the applied driver torque on the control is clockwise as viewed by the driver, the applied force by the actuators to the parallelogram causes a vehicle lean to the right and vica versa . Any loads coming from the parallelogram back to the driver control, will likewise be sensed by the servo valves and the servo valves will direct fluid to power assist the resistance to the altering of the parallelogram position relative to the drivers applied position on the control. In all respects this is a simple closed loop servo system well understood in the art. The actuators are mounted as shown, each with one end located to pivot on the vehicle structure and the other end located to pivot on the lower cross arm[13] and so to provide a means to apply a force to rotate the parallelogram around pivots[26,26a]. Of course the parallelogram cross arms remain horizontal to the road surface being supported in that plane by the laterally spaced wheels, and the force applied causes the vehicle structure to lean. The power system and its origins may be varied between one style and another. For example, a hydraulic pump engine driven [11] and an electric system operating off the vehicle battery [not shown], or an arrangement where one pump is engine driven and the other pump driven off the vehicle transmission [11a],as desired. The position of the actuators or power drive elements, the style of the driver connection to vehicle lean, the pump arrangements, and the style of servo valves may be varied as long as the basic function is adhered to.

Also is shown in FIG[5] a vehicle of type [e]. In this case there is a castoring element formed by one wheel. Two rear wheels are laterally spaced. The mechanical connection between driver input on the control [5] leads to the laterally spaced rear wheel carrier[in this case a parallelogram. The connection is via shafts [6,6a], and in series in this shaft is gear set [7] and servo valve [10]. The relative positions of the gear set and the servo valve can be varied as long as each item is in series in the shaft. The rear wheels may just as readily be attached to a support which does not allow the wheels to lean, but maintains them in a substantially vertical position, see FIG [6]. In this example of a laterally spaced rear wheel support structure the actuators [12,12a] are placed within the structure in a way which allows a force to be applied between the vehicle leaning structure and the ground reference created by the laterally spaced wheels, the vehicle leans around the pivot axis[14]

I will now give a description of the vehicle operation. In a steady state vertical position under way, the vehicle will steer a straight course. The vehicle will steer straight even with the drivers hands off the control.

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PATENT cont in this steady state position the directional stability is achieved by the natural tendency of the vehicle to seek a vertical position. If the vehicle tends to fall, say right, the front wheel/wheels turn into the fall and countersteer the vehicle back to the vertical. This characteristic is identical to "hands off" stability on a conventional motorcycle. When the driver wishes to turn say right, he applies a force to displace the control to the right which causes the vehicle to lean right. The lean to the right causes the vehicle front wheel/wheels to steer to the right due to a number of factors, including gyroscopic steer and the effect which causes a castoring wheel to turn into the direction of its inclination. The wheels seek a point of equilibrium where they are maintained by the camber steer forces acting on the contact patch. The vehicle steers into a stable curved path, the path being a function of vehicle lean angle and vehicle speed. In the hands off state the vehicle returns to vertical because there is no lean force to either side of the vertical. The fundamental difference between this vehicle and a normal motorcycle is that in a normal motorcycle there are no laterally spaced wheels, and the driver has to countersteer the control to lean the mass centre. As previously mentioned the countersteer re emerges in this system due to the forcing of the lean. A closer examination of a right turn is that as the driver applies a torque to steer the control right the vehicle mass resists displacement and causes the reaction spring in the servo valve to crack the valve .The valve then directs fluid to the actuators to cause a force to lean the vehicle.[as well as causing the countersteer reaction]. This process is achieved on a normal motorcycle by countersteering the control. As the process continues the wheels steer into the direction of the lean, creating a vehicle curved path and also creating a torque acting against the driver applied torque on the control. In this way the driver experiences feedback via the natural forces created in the system and the servo valve responds as required to produce a smooth controlled transition from one vehicle steady state to another. In the leaning right steering right steady state the driver will experience a distinct torque on the control tending to return the control to the central straight ahead position. Although there are no direct conventional connections between the driver and the steered wheels the connection is nevertheless quite present, being in the form of a dynamic transfer of the forces experienced by the steerable wheels road contact patches into the vehicle lean linkages and so to the driver control . And so it can be arranged that the control of the vehicle has identical characteristics to that of a conventional motor car, so allowing persons of average skills to easily perform the control .When the vehicle is at rest the driver retains control of the vehicle lean, and if he remove his hands from the control the vehicle seeks the vertical position due to a weighted element under the influence of gravity, optionally a simple lead weight on the steering wheel rim, or some such arrangement, which effect is amplified by the powered lean servo system. When the driver wishes to exit the vehicle he applies the handbrake which also locks the vehicle to the vertical.

As described so far the directionally steerable wheels are free to respond to the dynamic conditions. However, as speeds drop towards about 10 mph the strong bond between vehicle lean angle and the castoring wheel element starts to break down.This breaking down is progressive and becomes more obvious as speed drops to around 5 mph, until there is a very poor relationship. However of course, the driver retains control of the vehicle lean so the situation is still manageable. Additional location for the castoring wheel element is required for speeds below aprox 10mph,but this additional location can be applied progressively from a higher speed so that the driver is totally unaware of any transition Please refer to FIG's [7,7a] .One way to achieve this low speed control is by connections between the castoring element steer lever arms [19,19a] and a variable tension control unit [VTCU] [16] mounted on the vehicle leaning structure.[17].in such a way to produce a tendency for the vehicle castoring wheel element to steer in the direction of vehicle lean.. Briefly the VTCU is a variable coupling well known in the art. A rotating input shaft, by for example a small geared electric motor, is used as a source of torque. The torque is delivered to the output shaft via a variable coupling transmission. The variable

coupling can take many forms, magnetic, mechanical friction, or viscous friction or magnetic particle etc etc. The output torque is varied by controlling the transmission. A convenient method is to vary the transmission of the torque by electronic means by an ECU, a electronic control unit which may, for example, vary the voltage applied to a magnetic clutch. The term "Variable tension control unit" applies to the descriptions I will be giving which use tension control of cords which are drawn into the VTCU by winch drums driven by and incorporated within the unit. If other types of arrangements are contemplated the unit might be applied as a variable torque control unit or a variable force control unit, A vehicle electronic control unit sends signals to control the VTCU In FIG's [7,7a] is shown a basic diagram showing the layout of a system in a vehicle with two front wheels. The VTCU [16] is shown mounted on the vehicle leaning structure with cords [18,18a] running in pulleys [20,20a] and out to the wheel steer lever arms [19,19a]. The cords are attached to the VTCU via a connection[a], which joins cords[18,18a] into a single cord which is drawn into the VTCU winch drum. In the vertical straight ahead position FIG [7] [a view from above], imagine a tension applied by the VTCU on the cords [18,18a]. The tension is equal in both cords and so the wheels are urged to the straight ahead position. If the vehicle leans to the left FIG [7a] the cord [18a] maintains tension on the wheel set and the tension in cord [18] is removed. Cord [18] plays no part in the process as indicated by the dotted curved line. The wheels are urged to steer in the direction of the lean and the magnitude of the urging depends on the tension applied by the VTCU. Cord [18] plays no part until the vehicle is leaned in the other direction when a mirrored effect occurs. In FIG's [7,7a] it will be seen that the attachment points for the cords on the steer lever arms [19,19a] are higher than the running points on the pulleys[20,20a] and so as the vehicle leans the distance between the attachment points on one side increases and the distance on the other side decreases. The magnitude of the tension applied by the VTCU is variable as a function of vehicle speed, and also can be varied according to vehicle lean angle by a suitable vehicle electronic control unit[21]

Another variation of low speed control is now described in reference to FIG's [8,8a], a vehicle with one front wheel. In this arrangement the front wheel control is provided by cords[18] and[18a] connected between the winch drums [23] on the extremities of the VTCU [16] and the cross arm steer lever [22] on the front wheel steer axis. Both winch drums are driven by a common drive shaft. The VTCU is attached to the shaft [6] which is in fact a representation of the vehicle leaning structure. The distance between the attachment points for the cords on the winch drums is greater than the distance between the attachment points on the steer lever [22]. Again imagine the two cords in tension with the vehicle in the vertical position. The vehicle front wheel is urged into the straight ahead position, FIG[8a]. If the vehicle leans to the right [as depicted by the arrows] FIG[8], cord [18a] remains in tension while cord [18] slackens and takes no part in the process. The front wheel is urged to the right, and when the vehicle leans the other way a mirrored effect occurs.

An alternate version of the same operation is shown in FIG's[9,9a,9b,9c,9d.] In FIG's[9,9a] is shown a representation of a parallelogram leaning linkage supporting a laterally spaced castoring wheel set. An actuator body VTCU[16] is arranged to run on the actuator shaft [24] which is attached to the vehicle structure [17] The movement of the actuator is controlled by the vehicle electronic control unit as a function of vehicle speed. Two resilient cords [25,25a] are connected between the actuator body at points [26,26a]then to the wheel steer levers ,[19,19a]obscured, but visible in FIG[9d]. The energy stored in the resilient cords is produced by the position of the actuator body VTCU. In the vertical vehicle position FIG [9b] the tension applied to each steer lever arm is equal. As the vehicle leans, say to the right as depicted in FIG[9c], the distance between the attachment points on the actuator and the attachment points on the steer levers varies on either side. The tension in cord [25a] increased and the tension in cord [25] decreases. The bias of tension is shifted to steer the wheels in the direction of vehicle lean. In the other direction of lean a mirrored effect occurs. When the actuator body is positioned in the fully

down position FIG [9a][27] the tension created in the resilient cords is at maximum. This is the "dead slow" vehicle speed setting and the urging of the wheels to steer with the lean is at maximum. When the actuator body rises say to position FIG[9][27a] there is less bias of tension created during vehicle lean because the distance between the attachment points on the actuator and the attachment points on the steer levers varies less with vehicle lean and in the raised actuator position there is fundamentally less stored energy tension in the cords.

All of these low speed systems are fundamentally identical and rely on the position of the attachment points on the representation of vehicle lean being arranged relative to the position of the attachment points on the wheel/wheels steering arm/arms , so that as the vehicle leans a bias of tension is shifted to urge the vehicle wheel/wheels in the direction of vehicle lean, and the amplitude of the tension is a function of vehicle speed as controlled by the VTCU and the vehicle electronic control unit. When this system is correctly adjusted the driver experiences sharp and accurate steer in the 0 to 10mph speed range and the transition from tension assisted control to free to castor steer is unnoticeable. The diagrams given are an aid to the understanding of the system and many other methods may be employed to achieve the control principle. For example it is possible to arrange that the system is based on links in compression. For example in FIG[9e] the connections between actuator and steer levers have been made with links sprung in compression, and the steer lever arms have been reversed in their positions to face forward. This is quite clearly a system of the same basic principle as described in more detail previously and many arrangements of the principles can be performed and my invention is clearly intended to cover any arrangement of the fundamental principles.

An important fundamental characteristic of the vehicle so far described is the mechanical feedback to the driver via the control, due to the servo valve reaction spring recording the vehicles natural tendency to always return to vertical. This loading of the system is caused by the natural loads taking place on the contact patches of the wheels. Important consequences follow. When the vehicle is being forced down to lean into the corner, the weight on the outer wheels increases relative to the weight on the inner wheels. The vehicle is now gaining stability from its width of track, as well as its inclination. This allows the vehicle to corner at less of a lean angle for any given speed and radius of corner. The flow on effect is that the driver experiences a lateral loading which assists his judgement of his steer inputs. The term "loadshedding" is used to describe this condition. The amount of load shedding can be easily varied throughout the vehicles full speed range by arranging the low speed tension control to operate outside its normal range under control of the vehicle electronic control unit and so various rates of lean steer and loadshedding can be applied to the vehicle as desired.

Other methods may be used to vary or maintain the steer angle of the castoring element. The driver may be provided with a second control input which can either replace the VTCU or operate in conjunction with the VTCU. For example with reference to FIG [10] there is shown a vehicle of type [d,e] where the driver is provided with foot pedals[28,28a]. The pedals rotate about axis [29] and are supported in the vehicle structure [17].In this version each pedal is isolated from the other there being no connection of their support axles[30,30a]. A force applied to pedal [28] by a drivers foot will tend to rotate the front wheel about its steer axis [31]. Likewise a mirrored effect occurs when a force is applied to pedal [28a]. The mechanical connection between pedals and front wheel is via lever arms [32a] and [32][not visible], and connecting rods [33,33a] to the cross arm lever[22], the connecting rods being fitted with moveable joints at their ends. The connecting rods may have elastic elements [38,38a] fitted to vary the force / displacement ratio of the pedals In FIG [10] the pedals are shown operating in conjunction with the VTCU [16], however the VTCU can be omitted and the pedal system can operate alone. A variation is shown in FIG [10a]. Here the driver's control [5] has been fitted with a squeeze bar [34] which is located to slide and rotate on shaft [6], and can be drawn closer to the control [5] by the drivers fingers in a squeezing action. The squeeze

applied by the driver provides the variable tension to the cords [18,18a] which run in guides at the extremities of support [35]. The distance apart of the running points for the cords on support [35] is greater than the distance apart of the attachment points for the cords on the cross arm [22]. Suitable spring loadings can be provided by a spring [36] arranged to sit on a collar [37] on shaft [6] as shown. The cords may have elastic elements [38,38a] fitted to vary the force/displacement ratio of the squeeze bar movement. The operation of this arrangement is identical to the system described in FIG [8] except that the driver manually applies the tension control. In FIG's [11,11a] is shown similar arrangements applied to a vehicle of type [a,b,c,]. In the arrangement in FIG [11] the pedals [28,28a] are fitted to rotate in support [35] attached to the vehicle structure [17]. The pedals have a common axle rotating on axis [29]. A force applied to either pedal will apply a tension in cords [18,18a] and the system will operate as previously described in FIG's [7,7a] except that the tension is applied by foot pressure. The cords may have elastic elements [39,38a] fitted to vary the force /displacement ratio of the pedal movement. Alternatively the pedals can be arranged to be fitted on independent axles FIG [11a]. Now the driver may apply a force to alter or maintain the position of the steerable wheels totally independently of the control [5] via lever arms [32,32a],which connect to cords[18,18a]which travel in guides and are attached to wheel steering arms [19,19a].The cords may have elastic elements fitted to vary the force/displacement ratio of the pedals. Again, a spring can maintain the system in a loaded condition as required. In FIG [12] is shown a variation of the arrangement described in FIG [10a]. The arrangement in FIG [12] is identical to that shown in FIG [10a] except that the cords [18,18a] are attached to a two wheel castoring element. With regard to the manner of the orientation of the connection of the pedals to the steer of the front castoring element, it has been observed that it matters little whether a push on the right pedal steers the vehicle right or if a push on the left pedal is arranged to steer right. The fundamental importance is that the input is simple steer. The vehicle "teaches" the driver the method; the pedals not being actually required simply reinforce the simple steer input on the hand control into a "full body simple steer input". It will be understood that the systems being described with the use of cords in tension can be achieved by the use of rods and levers to perform identical function and that the function can also be arranged to operate in compression by various methods which would be obvious to anyone skilled in the art, and my invention claims coverage for these many various arrangements as long as the fundamental effects as described herein are performed. The various translations of forces can be applied mechanically, hydraulically or electrically.

A vehicle of this invention using a castoring element comprising of two wheels is best served by a suspension which is now described, please refer to FIG [13,13b] The upper and lower cross arms of the parallelogram[13] and[8] are one piece items pivoting off their centres[26] and [26a] on axles located on the vehicle structure. Each cross arm has ball joints [40a,b,c,d,] fitted to their ends which attach to the closed fork uprights [2,2a], which allows the parallelogram to lean and the uprights to turn in steering. The wheel stub axles[39,39a] are fitted to axle carriers [40,40a] which run on the parallel bars[41] which form part of the uprights. The lever arms [1,1a] which connect the two wheels in alignment via track rod[3] are mounted on the uprights and so are the lever arms which are used during low speed control [19,19a] When the wheels move in suspension the steer levers and track rod do not move. This arrangement prevents any form of bump steer occurring at any angle of vehicle lean and the arrangement also causes the vehicle wheels to move in the same plane as their inclination when the wheels move in suspension at any angle of vehicle lean. This ensures that the wheels behave in a similar manner to the wheel on a motorcycle, and the vehicle tyres follow the natural rolling path at all times over bumps and hollows in the road surface. The lean action and the suspension action are totally distinct. The suspension element can be located as desired between the wheel carriers and the uprights and some variations are shown.

APPLICANT:
DATE. 28 Sept. 2004.

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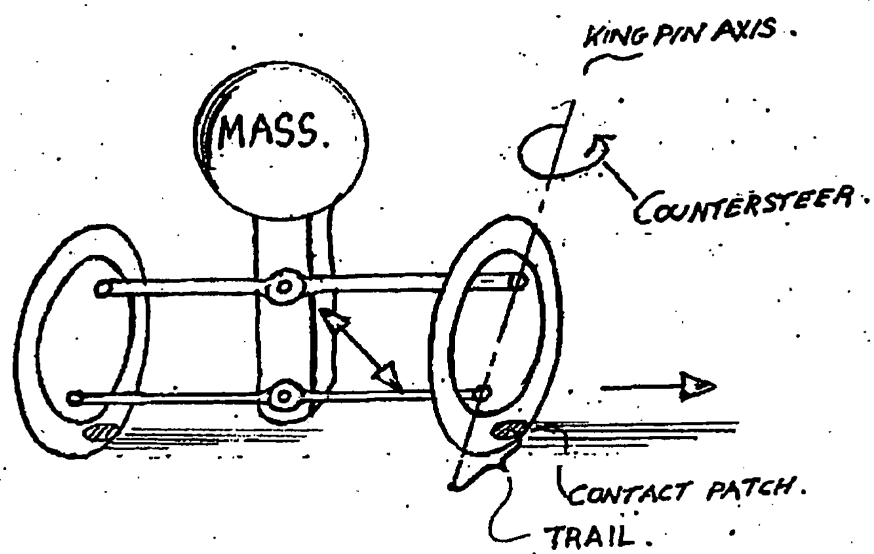

Fig-1a.

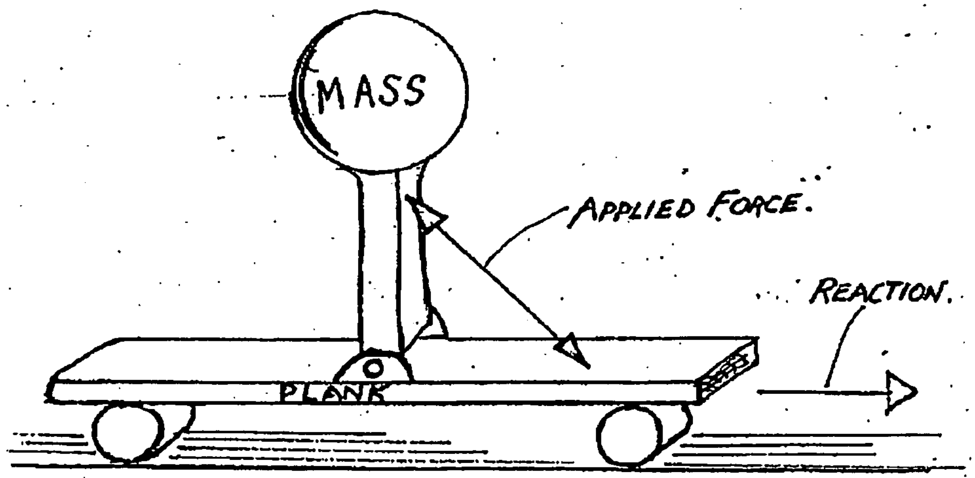

Fig-1.

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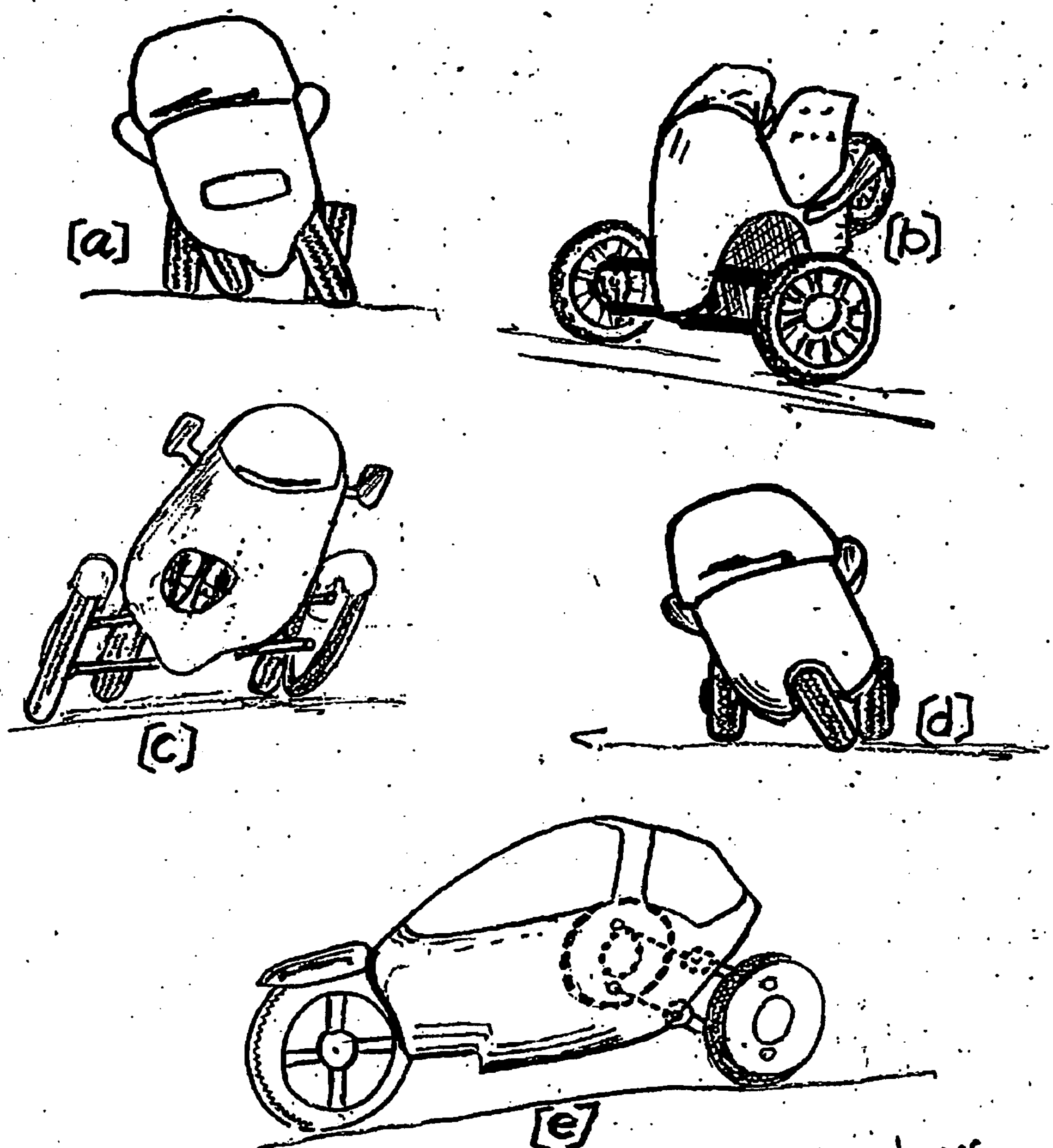

Fig-2

Phillip James

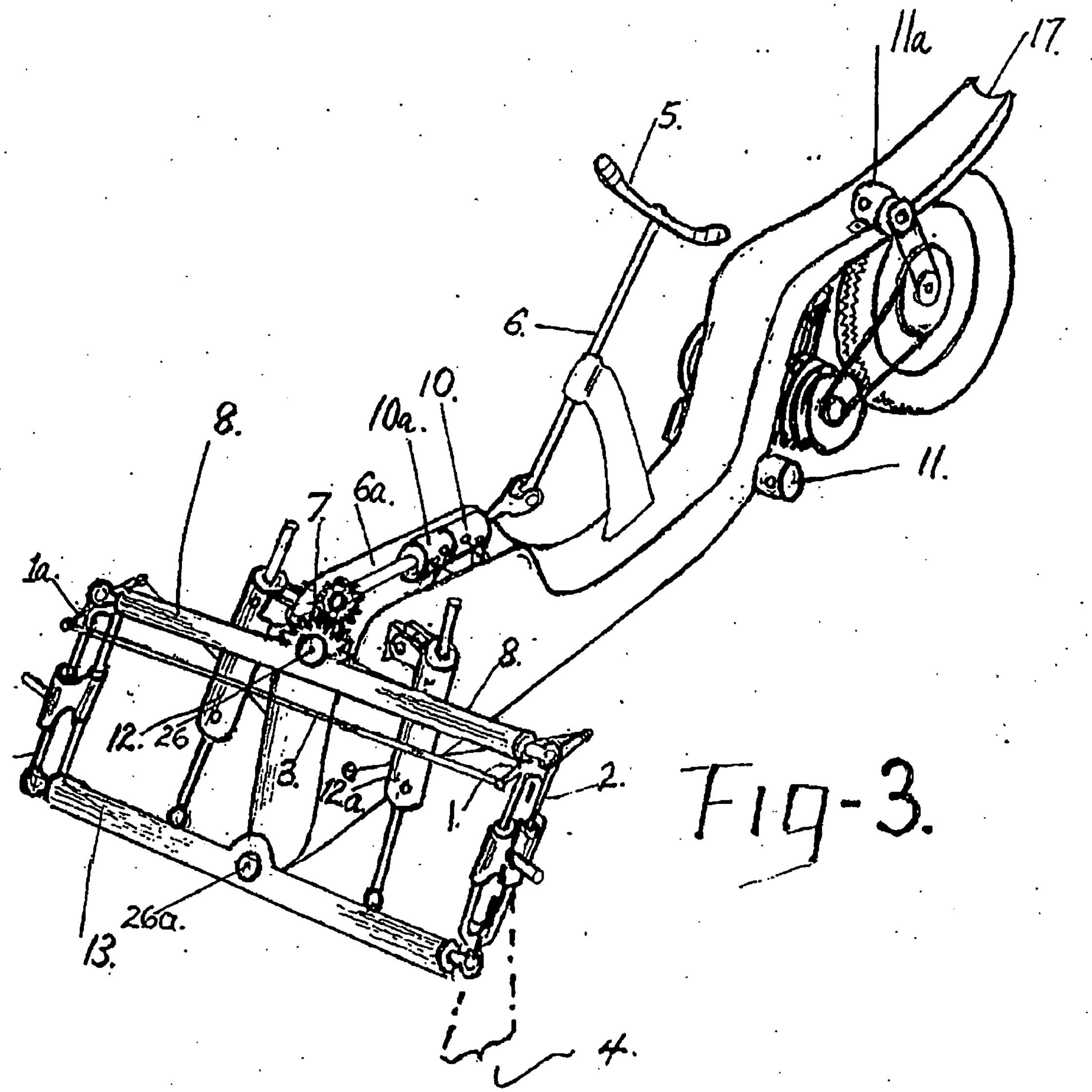

Fig-3.

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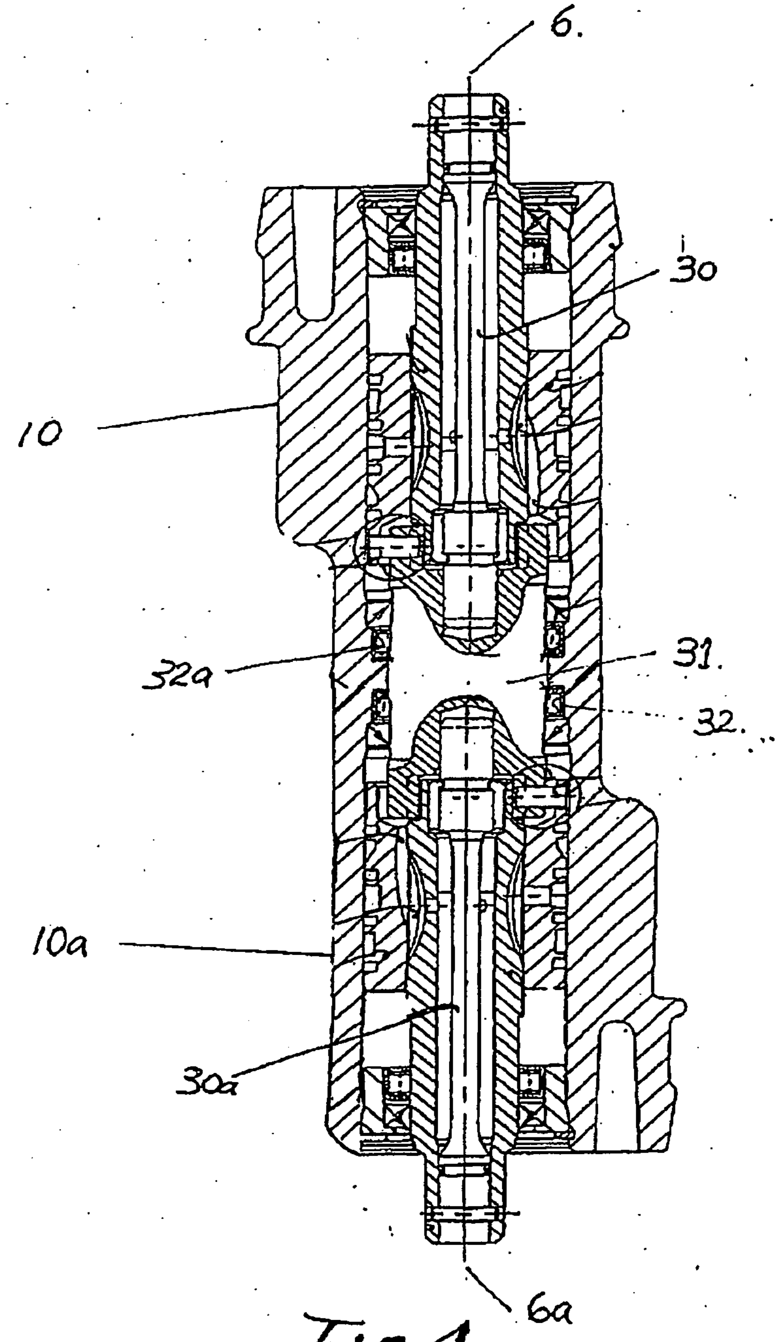

Fig. 4.

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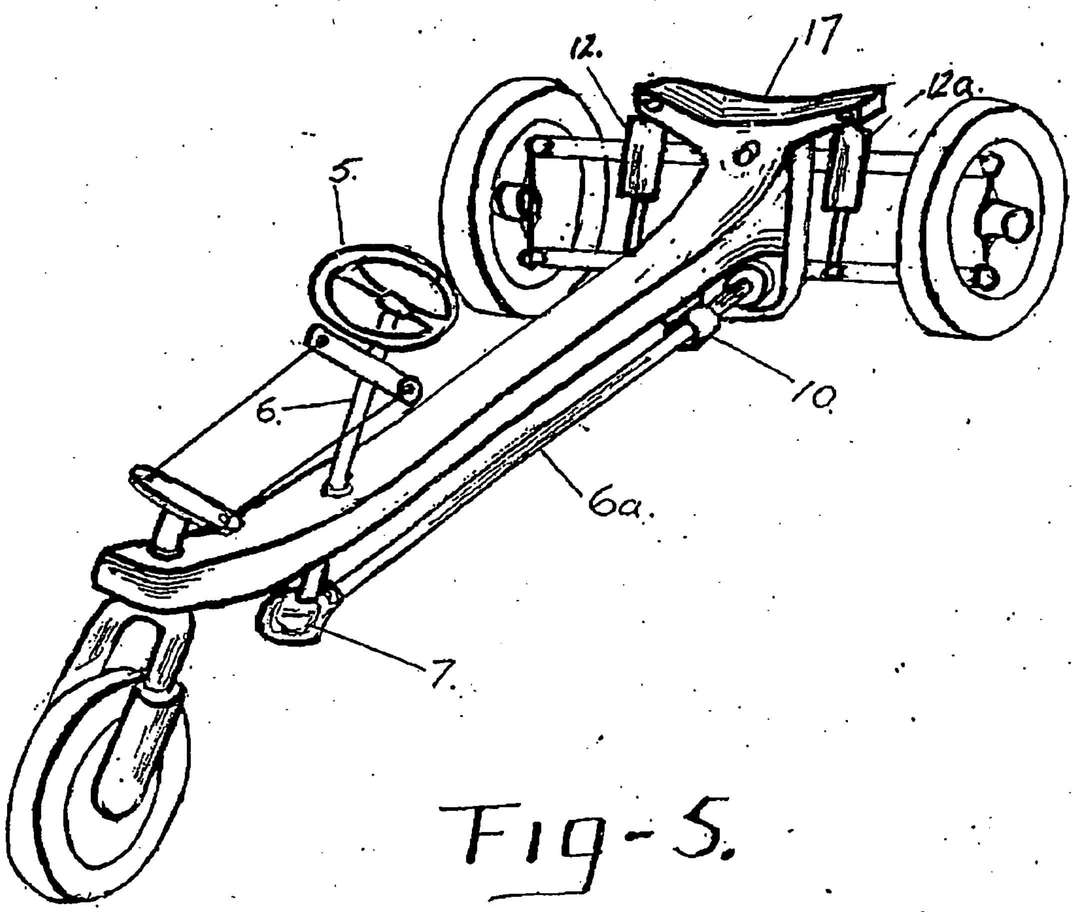

Fig-5.

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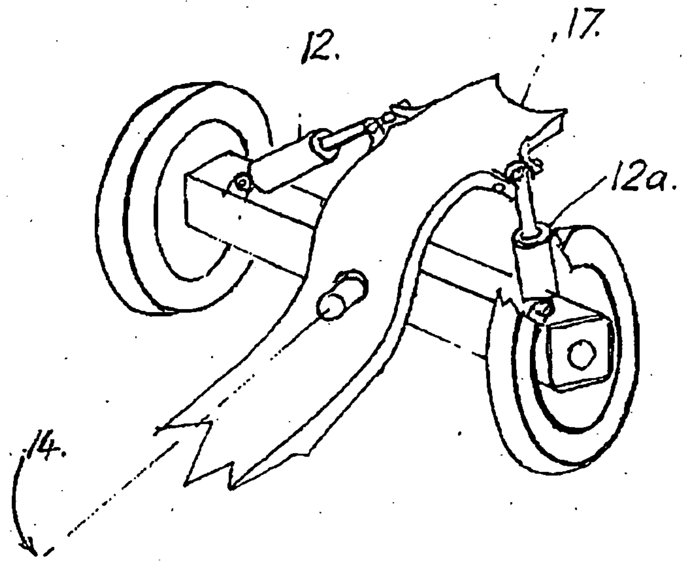

Fig-6.

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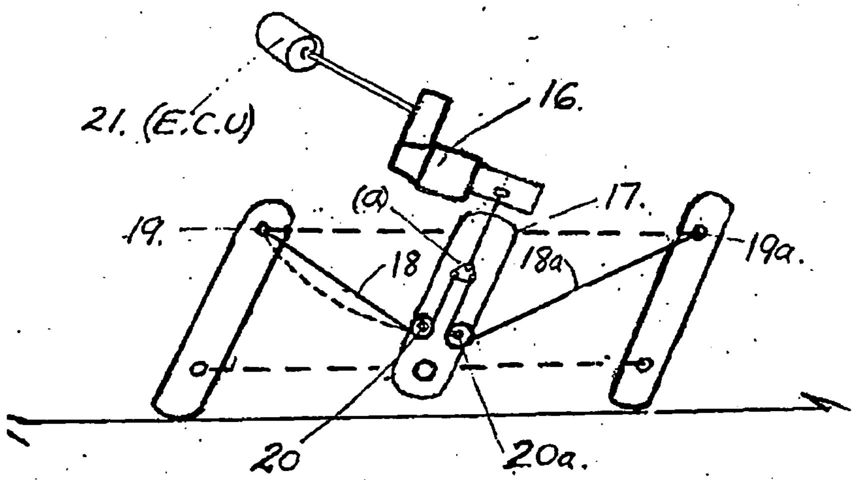
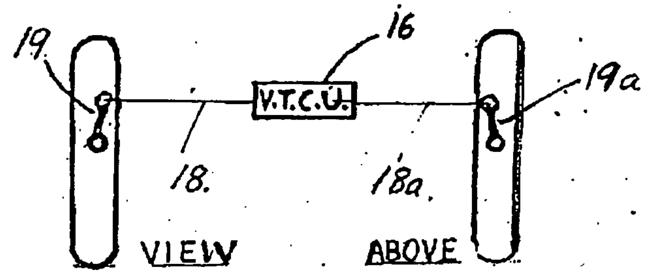


Fig-7a.



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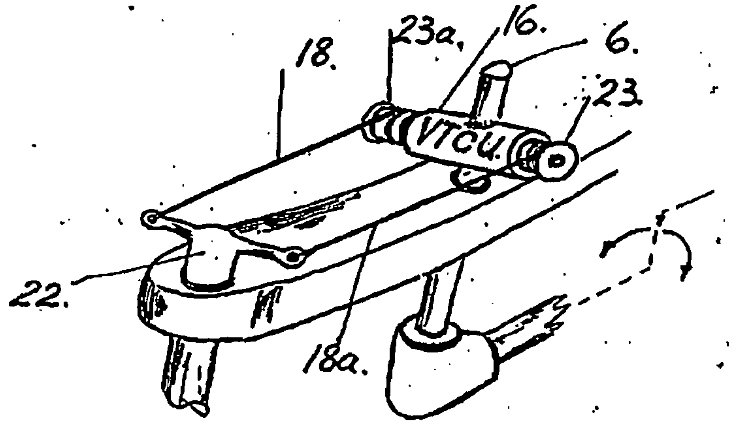


Fig. 8a.

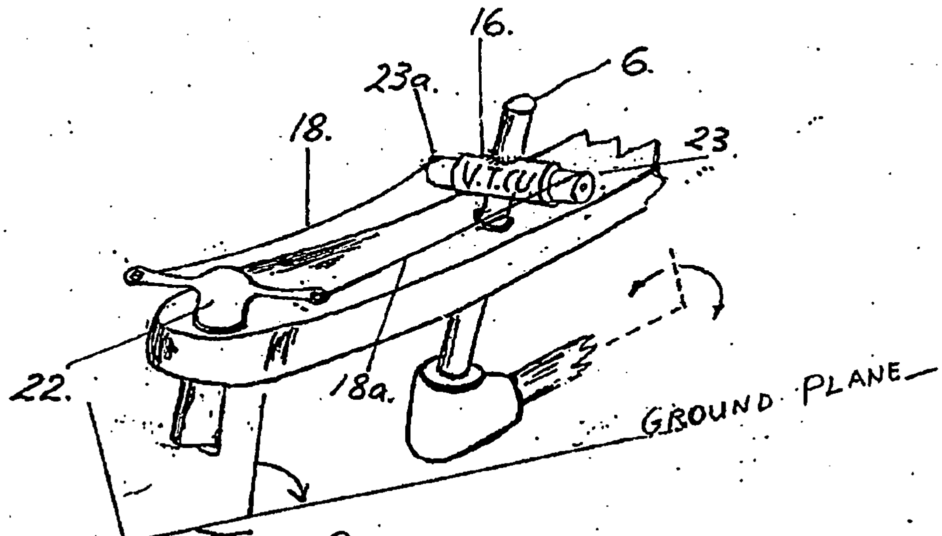


Fig. 8

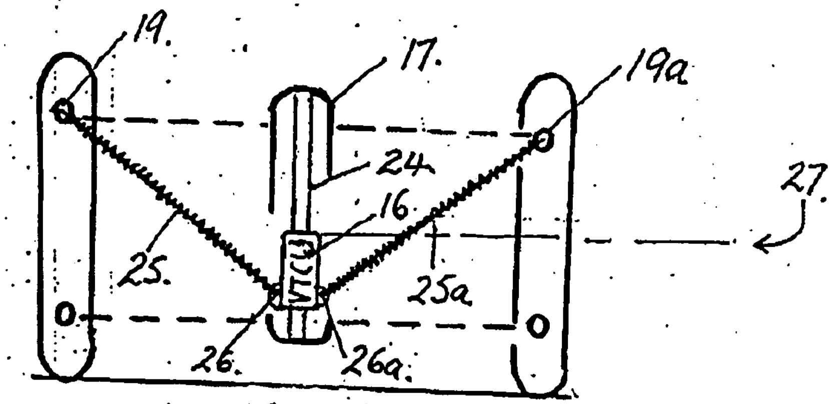


Fig-9a.

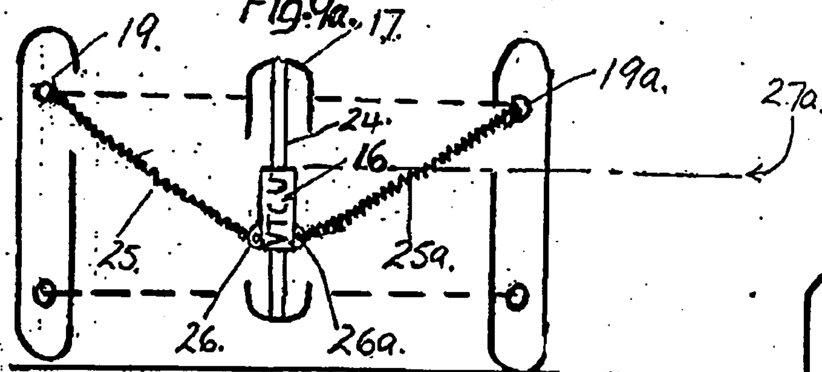


Fig-9

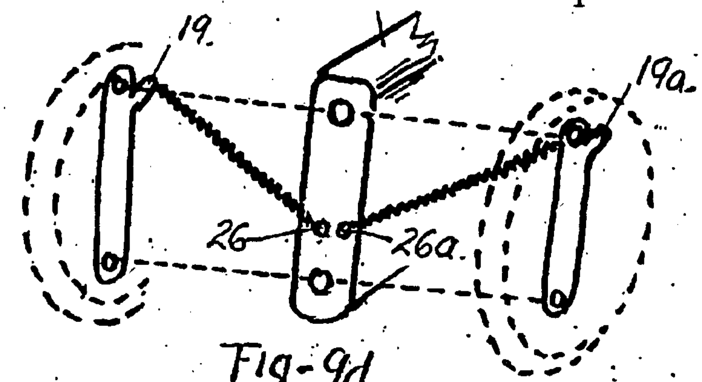
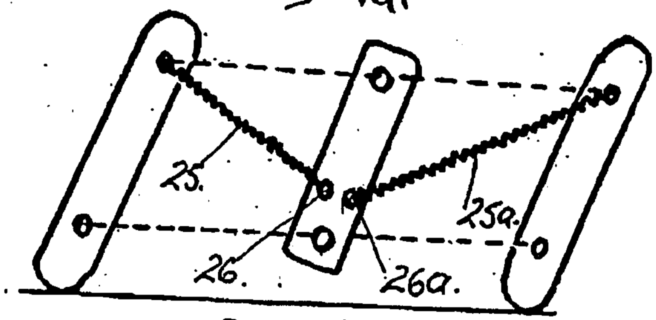


Fig-9d.



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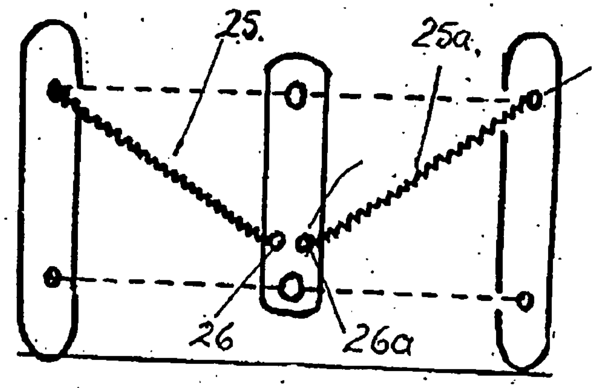

Fig-9b.

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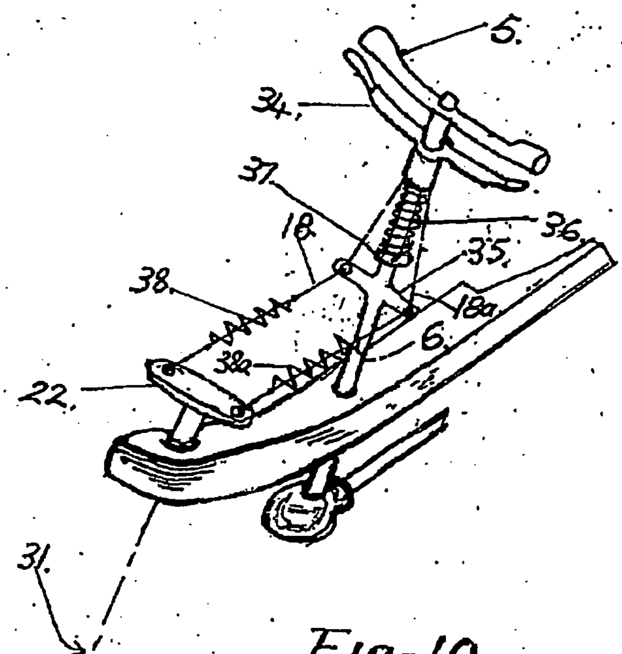

Fig-10a.

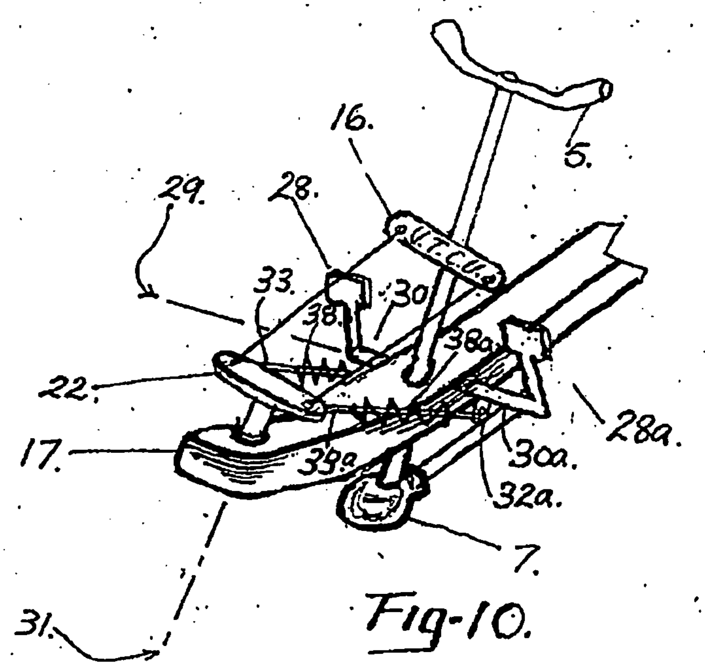

Fig-10.

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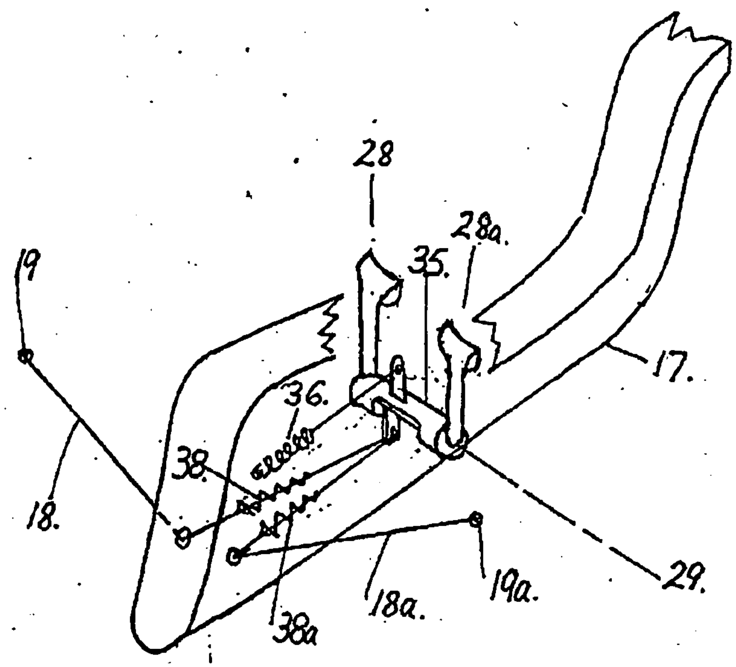

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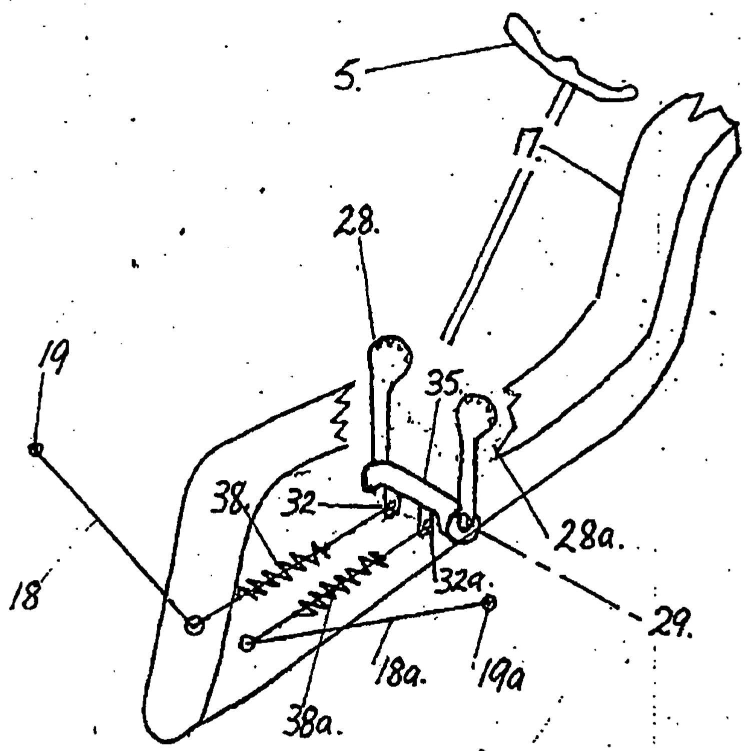
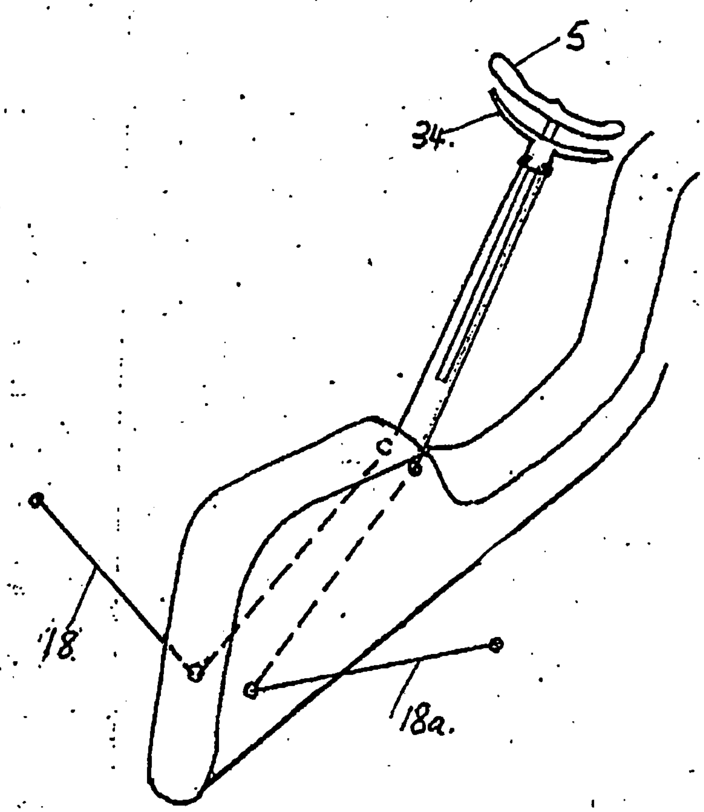


Fig-11a.



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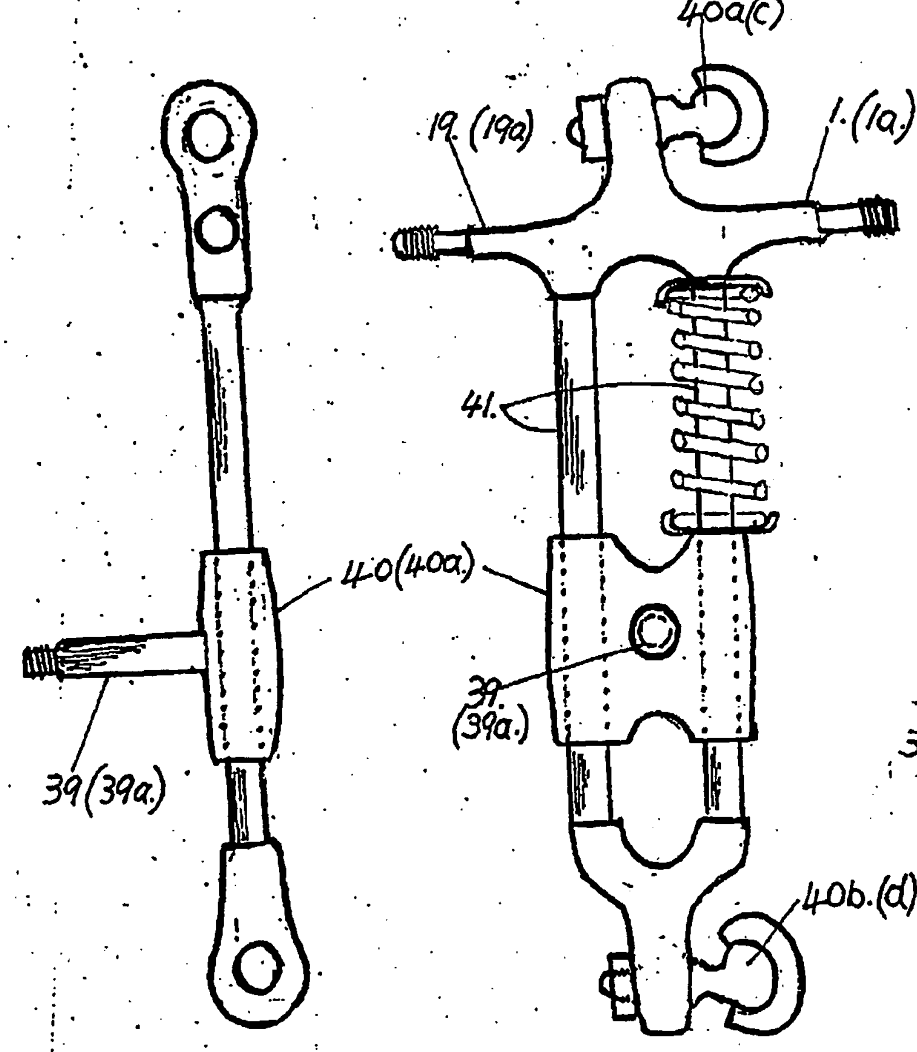
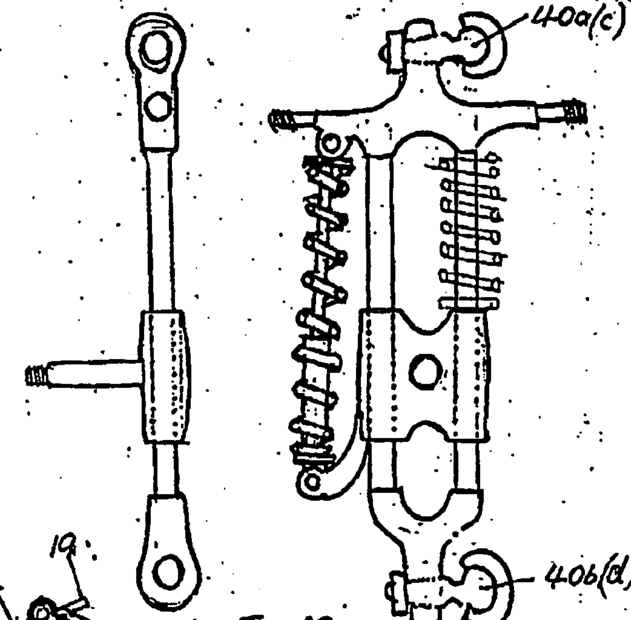


Fig-13



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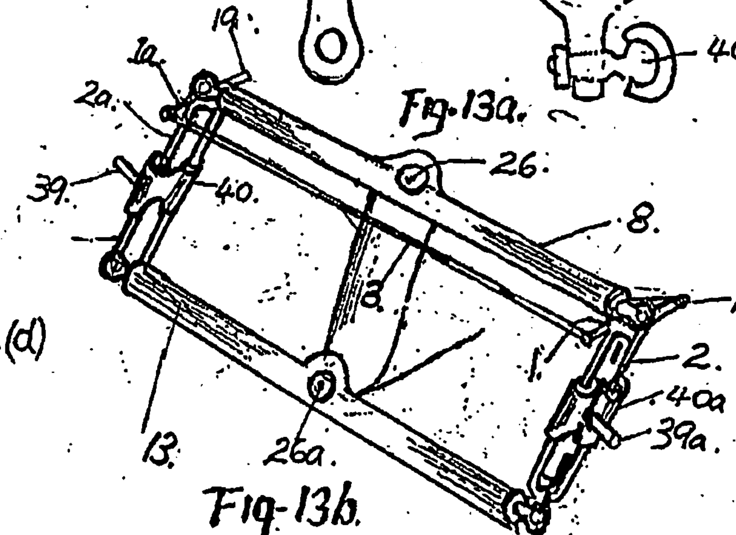

Fig-13b.

105868/9

PCT/AU05/000110

PATENT COOPERATION TREATY

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JAMES, Pillip, Ronald
PO Box 1060
Kilburn North, S.A. 5084
AUSTRALIE

Date of mailing *(day/month/year)* 23 March 2005 (23.03.2005)	
Applicant's or agent's file reference	**IMPORTANT NOTIFICATION**
International application No. PCT/AU05/000110	International filing date *(day/month/year)* 02 February 2005 (02.02.2005)
International publication date *(day/month/year)*	Priority date *(day/month/year)* 06 February 2004 (06.02.2004)
Applicant JAMES, Phillip, Ronald	

1. By means of this Form, which replaces any previously issued notification concerning submission or transmittal of priority documents, the applicant is hereby notified of the date of receipt by the International Bureau of the priority document(s) relating to all earlier application(s) whose priority is claimed. Unless otherwise indicated by the letters "NR", in the right-hand column or by an asterisk appearing next to a date of receipt, the priority document concerned was submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b).

2. *(If applicable)* The letters **"NR"** appearing in the right-hand column denote **a priority document which, on the date of mailing of this Form, had not yet been received by the International Bureau** under Rule 17.1(a) or (b). Where, under Rule 17.1(a), the priority document must be submitted by the applicant to the receiving Office or the International Bureau, but the applicant fails to submit the priority document within the applicable time limit under that Rule, **the attention of the applicant is directed** to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

3. *(If applicable)* **An asterisk (*)** appearing next to a date of receipt, in the right-hand column, denotes **a priority document submitted or transmitted to the International Bureau but not in compliance with Rule 17.1(a) or (b)** (the priority document was received after the time limit prescribed in Rule 17.1(a) or the request to prepare and transmit the priority document was submitted to the receiving Office after the applicable time limit under Rule 17.1(b)). Even though the priority document was not furnished in compliance with Rule 17.1(a) or (b), the International Bureau will nevertheless transmit a copy of the document to the designated Offices, for their consideration. In case such a copy is not accepted by the designated Office as the priority document, Rule 17.1(c) provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

Priority date	Priority application No.	Country or regional Office or PCT receiving Office	Date of receipt of priority document
06 February 2004 (06.02.2004)	2004900556	AU	08 March 2005 (08.03.2005)
30 September 2004 (30.09.2004)	2004905617	AU	08 March 2005 (08.03.2005)

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